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REVIEW

CT guided biopsy using additional laser guidance: Case series from India comparing with conventional free hand technique

Vyshakh V. Honganoor *, **Shyam Kumar N. Keshava, Vinu Moses, Munawwar Ahmed**

Department of Radiology, Christian Medical College, Vellore, India

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KEYWORDS

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Abstract Additional laser guidance during CT guided biopsy has shown promising results in terms of accuracy and patient throughput. We used a simple laser guidance unit that can be easily integrated with any of the CT units for additional laser guidance. We report the first case series of CT guided procedures done using this laser device in India comparing it with conventional free hand techniques.

Contents

* Corresponding author at: Department of Radiology, Christian Medical College, Hospital Ida Scudder road, Vellore, India. Tel.: +91 80 23357035, +91 9739208604; fax: +91 80 23133844.
E-mail address: vyshakh2006@gmail.com (V.V. Honganoor).
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1. Introduction

With the expanding scope of percutaneous interventions CT guided procedures have become an important component of the work flow in a radiology department. CT guided procedures do not have real time guidance and significant complications and increase in radiation dose can occur due to needle malposition.

Additional laser guidance during CT guided biopsy has shown promising results in terms of accuracy and patient throughput. Laser guidance can also prevent frequent needle malpositions thereby reducing the number of check/control scans and radiation dose and possibly the complications.

We evaluated a laser guidance system from NeoRad AS, Norway that can be integrated to any CT unit.

The aim of this study was to evaluate the new laser guidance system and compare CT guided procedures done with laser guidance and without laser guidance in terms of the following-number of control/check scans done before taking the biopsy, total radiation dose and complications and yield of the procedure.

2. Subjects and methods

The study was carried out in the department of Radiology. The study was a historical cohort with clearance from the institutional review board.

All the requests for CT guided procedures were first evaluated by a radiologist to check for the feasibility of the procedure. If feasible the requests were accepted and the procedure scheduled for a particular date. All the patients underwent work up for bleeding parameters-PT/APTT, platelet count and were screened for blood borne viruses. Patients undergoing CT guided biopsy/FNAC/aspiration were included and patients undergoing CT guided RF ablation/alcohol injection/Lumbar sympathectomy were excluded from the study.

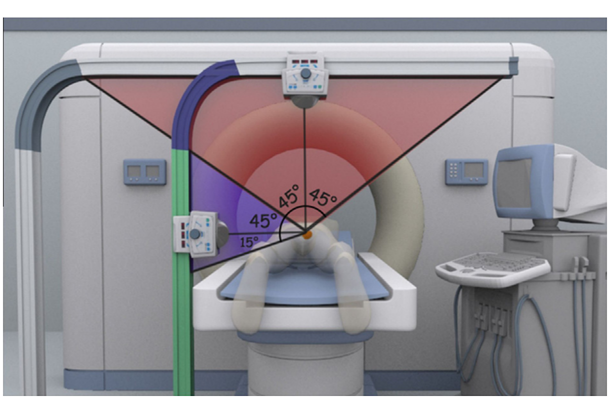

Fig. 1 Figure describing the coverage of the laser unit.

Patients with deranged bleeding parameters were given prophylactic fresh frozen plasma cover as advised by the haematology department and were taken up for the procedure if cleared by the haematology department. All the procedures were done on an inpatient basis.

All the procedures were carried out on SOMOTOM PLUS CT [Siemens Medical systems, Germany]. All the biopsies were carried out using a COOK 17G co-axial system with an 18G biopsy gun.

The procedure was carried out by experienced radiologists.

The laser guidance system used was SimpliCT™, NeoRadAS, Norway. It consists of a movable laser unit mounted on a rail. The laser unit can be moved on the horizontal as well as the vertical rail. The device is suspended above the patient and provides a laser light pointing to the puncture angle. The laser guidance system can be used with any type of CT unit or C-arm CT. A prerequisite is that the CT-unit (gantry and the table) and the angles displayed by the unit are correct relative to the vertical.

When the laser unit is in the horizontal rail it covers 45 degrees on either side of vertical and when the laser unit is in the vertical rail it covers 45 degrees on either side of horizontal, but entire 45 degree angulation from below the horizontal is not feasible in view of the CT table coming in the way and the possible angulation may be 10–15 degrees from below the horizontal. The laser does not work in grey part of the rail. However this can be overcome by moving the assembly back and forth the CT machine and the entire 180 degrees to reach a particular target within the body may be achieved as illustrated by Fig. 1. Added to this 10–20 degree angulation from below the horizontal on either side, the machine can cover a total range of 200–210 degrees.

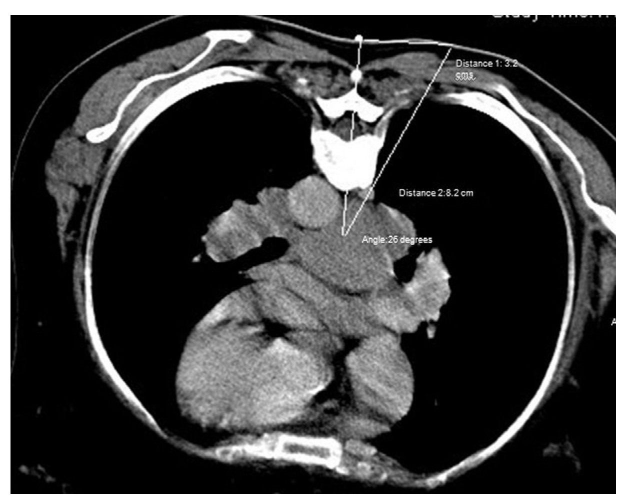

Fig. 2 Planning CT scan detailing the measurements and the angle calculations.

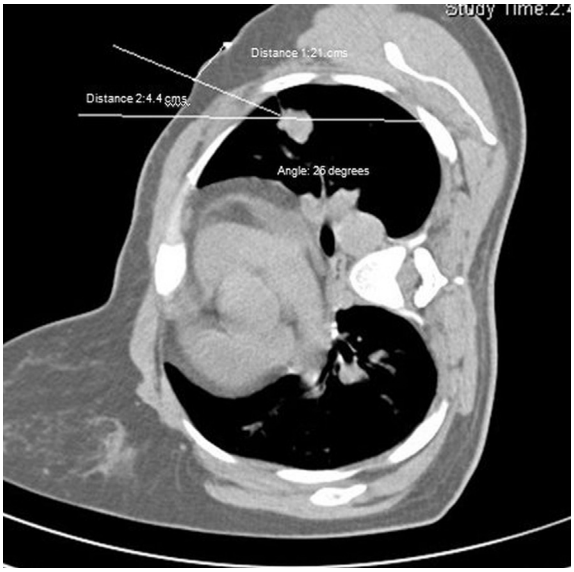

Fig. 3 Planning CT scan detailing the measurements and the angle calculations.

Fig. 5 Movable laser unit of the machine. The red arrow in figure points to the align button which has to be turned on prior to aligning the laser unit. The edge of the CT table being used to align the laser using line laser which is turned on after pressing the align button.

Fig. 4 Movable laser unit of the machine. The black arrow points to the X/Y angle wheel which has to be turned to set the desired angle for punctures in the axial plane.

The laser guidance machine was available as a trial unit for a fixed time period – and hence sampling was purposeful. All patients accepted for CT guided procedures when the machine was available underwent the procedure using laser guidance and the results were then compared with patients who underwent the procedure without laser guidance. The study was conducted in the month of January. Overall 26 patients underwent the procedure with laser guidance and their results were compared to 29 patients who underwent the procedure without laser guidance.

3. Steps of the procedure

3.1. Step A

Planning CT including the area of interest with a marker-this is similar to conventional free hand technique.

A radio-opaque marker-usually a catheter is placed along the long axis (Z-axis) of the patient and a planning CT is taken including the area of interest. The ideal axial section is chosen for the puncture and the distance from the skin marker to the puncture point and the depth from the puncture point to the lesion are marked out in the CT console as shown in Figs. 2 and 3. The angle of puncture direction is then measured; for punctures in the vertical direction with vertical laser beam guidance the angle is measured from the perpendicular taking the perpendicular as zero degress as shown in Fig. 2. For horizontal laser beam guidance the angle is measured from the horizontal taking the horizontal as zero degrees as shown in Fig. 3.

3.2. Step B

As in conventional free hand technique the table position (TP) for the marked image in the console is noted and the CT machine brought to the same TP. The laser light of the CT machine is turned on and the entry point is measured out from the skin marker and marked on the skin surface as planned on the CT image. The laser guidance device is then turned on. The machine can either be placed on the right or left side of the patient and the laser unit on the horizontal or vertical rail as decided by the plan. For punctures in the axial plane (X/Y-plane) the X/Y-button was pressed (black arrow in Fig. 4). The Angle input wheel was then rotated (Fig. 4) to set the desired angle found in step A. The pointing laser light is then confirmed to be angled in the correct direction on the patient.

3.3. Step C

The laser guidance system is then aligned by using the line laser by pressing the align button (red arrow in Fig. 5). The laser unit is then moved and the edge of the CT table is used for alignment (Fig. 6). The movable laser unit is moved back to

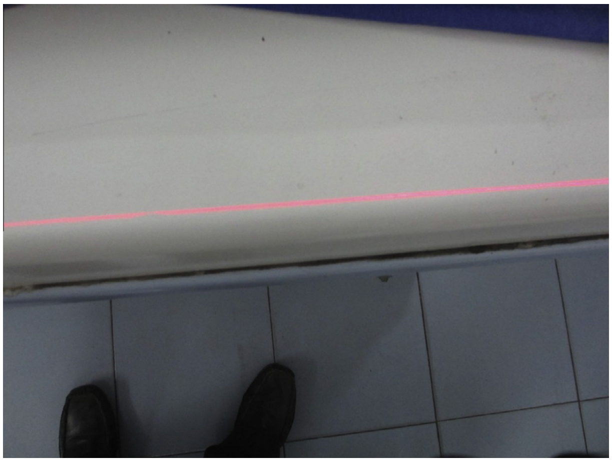

Fig. 6 Movable laser unit of the machine. The red arrow in Fig. 5 points to the align button which has to be turned on prior to aligning the laser unit. The edge of the CT table being used to align the laser using line laser which is turned on after pressing the align button.

Fig. 7 Image showing the laser light pointing to the entry point at the planned angle.

Fig. 8 Inserting the needle with the laser light continuously illuminating the centre of the needle hub.

Fig. 9 Inserting the needle with the laser light continuously illuminating the centre of the needle hub.

its original position as found in Step B. The machine is then locked.

3.4. Step D

The X/Y fine adjustment wheel is used to point the laser exactly at the at the entry point (Fig. 7).

3.5. Step E

After giving local anesthesia and a small skin incision the tip of the puncture needle/Co-axial system is placed at the marked entry point where the laser light is pointing. The needle is introduced into a certain depth (usually not up to the planned depth) depth while the laser light continuously illuminates the centre of the needle-hub (Figs. 8 and 9); both the hands are used to introduce the needle (Figs. 8 and 9) to avoid bending of the needle. A control CT is performed to check the accuracy of the direction and if found satisfactory the needle is introduced in the similar fashion as described above up to the planned depth. A control scan is again performed to assess the needle tip position and if found satisfactory biopsy is performed (Fig. 10).

4. Study design

The aim of the study was to evaluate the laser guidance system. The study was designed as a historical cohort study with purposeful sampling of patients.

The results of 26 patients who underwent the procedure using laser guidance were compared with 29 patients who underwent the procedure without laser guidance. Total radiation dose during the procedure (calculated in terms of dose length product) and the total number of check scans done prior to the biopsy was noted in all the patients from the CT console monitor. Occurrence of any complications were recorded in all patients from the CT guided biopsy report/note made in the RIS (radiology information system). The yield of the procedure-in terms of adequacy of the specimen was obtained by following up the patients on hospital information systems (HIS)

Fig. 10 Image showing the coaxial needle tip in the lesion.

The total radiation doses were presented as means; the mean radiation doses were compared between laser guidance and no laser guidance using Student's t test and the mean difference with their 95% CI was calculated. The number of check scans were presented as medians with their interquartile range (IQR) and Man–Whitney U test was used to test the difference between the two groups. Test of proportions was used to test the difference in yield between the two sets.

5. Results

5.1. Location

Table 1 describes the anatomical location of the lesions targeted with laser guidance and Table 2 describes the location of the lesions targeted without laser guidance.

Overall majority if the lesions were in the thorax (45.5%) followed by bone (34.5%). We were able to target the lesion in all the cases in both the subsets. The laser was mounted on the horizontal arm in 25 cases and only one case the laser unit was mounted on the vertical arm for horizontal laser beam guidance. The mean puncture angle for vertical laser beam guidance was 17.2 degrees from the vertical and the single case which used horizontal laser beam guidance had a puncture angle of 26 degrees from the horizontal.

5.2. Number of control scans and total radiation dose

The total radiation dose was measured as dose length product (in mGy.cm) presented as means in the two subsets; the mean difference with the confidence interval was calculated and the independent t test was used test the significance of difference between the two groups as illustrated in Table 3.

The total radiation dose was significantly different when compared between the two sets and the mean difference in radiation dose between the two sets was 61.403 (CI: 28.040, 98.766).

The number of control scans were presented as medians (Table 4) and median test was used to test the significance of difference in the median between the two groups and the difference was statistically significant – P value 0.02.

Table 1 Anatomical location of targeted lesions using laser guidance.

Location	Number
Thorax-lung and mediastinum	12
Bone	8
Abdominal lymph nodes/adrenal	4
Paravertebral mass/psoas abscess	2

Table 2 Anatomical location of targeted lesions without using laser guidance.

Location	Number
Thorax-lung and mediastinum	13
Bone	10
Abdominal lymphnodes/adrenal	3
Paravertebral mass/psoas abscess	3

Table 4 Median check scans in the two groups; IQR: Inter quartile range.

CT guided procedures	Laser guided	No laser guidance	P value
Median (IQR)			
Number of check scans	2 (2–4)	4 (2.5–6)	*0.029*

P values are used for checking statistical significance, <0.05 is significant.

Table 3 Total radiation dose in the two groups measured as dose length product.

Group	Number	Mean DLP in mGy.cm	SD	Mean difference with 95% CI (UCI,LCI)	P value
No laser guidance	29	206.17	72.49	**61.403 (28.040,98.766)**	**0.001**
Laser guidance	26	144.77	49.58		

SD: standard deviation.
CI: confidence interval.
P values are used for checking statistical significance, <0.05 is significant.

5.3. Yield of procedure

The sample was diagnostic in out 22 cases (84.6%) done under laser guidance and in 23 (80%) cases done without laser guidance.

3 bone biopsies and one abdominal mass biopsy done under laser guidance were deemed non-representative/non-diagnostic by the pathologist. Four bone biopsies, one abdominal mass lesion and one lung mass biopsy done without laser guidance were deemed non representative. Test of proportions was done to determine the difference between the two groups and it was not statistically significant ($P = 0.74$).

5.4. Complications

Thin sliver of pneumothorax was documented in 3 cases each in both the groups for lung biopsies. No further intervention was required and the pneumothorax resolved on follow up radiographs.

6. Discussion

The role of percutaneous CT guided procedures – biopsies, abscess drainage, FNAC etc have expanded rapidly in clinical practice and form an important component of the work flow of radiology department.

Unlike USG guided procedures where there is real time guidance, usually CT guided procedures do not have real time guidance and the needle position is checked after positioning the needle. Usually CT guided procedures are performed using free hand technique without additional guidance device. However when the target lesion is small and deep, free hand techniques may be time consuming requiring numerous needle passes increasing the radiation dose to the patient. Needle malpositions are especially problematic in the lung where the complication of pneumothorax increase decreasing the diagnostic yield (1,2).

Real time CT fluoroscopy is an encouraging tool also addressing patient movement and respiratory movement, however CT fluoroscopy is not widely available and the possibility of higher radiation dose to the patient and the performing radiologist is still an issue (3).

Numerous guidance devices have been developed which have to be connected to the CT machine and integrated to the CT soft ware with promising results – but they have to mechanically integrated to the CT unit unlike the device we evaluated (4–6).

Laser guidance devices are a novel method for guidance during CT procedures. Studies using laser guidance have demonstrated that laser guided procedures to be very accurate with respect to positioning of the needle within the lesion (7–11). Studies comparing free hand technique with laser guidance have also demonstrated laser guided CT biopsy as more accurate compared to conventional free hand techniques (8,12). The study by Koppel et al. compared results between 54 cases of CT guided interventions with laser guidance and 40 cases of CT guided interventions without laser guidance and concluded that laser guidance decreased the number of control scan from 30% to 50% and the number of needle corrections by a maximum of 30% (12). The study by Pereles et al. demonstrated that that 93% of laser-guided passes and 56% of freehand passes were within 1 cm the intended target and concluded that laser-guided CT biopsies were more accurate than the conventional freehand technique (8). A phantom study comparing the two techniques by Jacobi et al. demonstrated that the accuracy of beginners improved with laser guidance and experienced puncturers benefited from laser with small and hard-to-reach lesions (7).

Our aim in this study was to evaluate a new laser guidance device and assessing its feasibility for integrating it as a routine practice to all CT guided procedures. The device we evaluated is a simple device requiring no additional mechanical integration with the CT unit. To our knowledge this is the first case series from India comparing laser guidance with conventional free hand technique. A previous study evaluating the laser device in question – SimpliCT, concluded that the laser system is easy to use. The study demonstrated a high level of accuracy regarding the angle of insertion and the mean angle difference between the planned and the reached puncture angle was 1.8 ± 2.1 degrees. However the study did not compare the laser guided CT guided procedures with conventional free hand techniques (13).

Our study showed very promising results with respect to reduction in the number of control scans and the total radiation exposures to the patient when laser guidance was used. We postulate that using laser guidance would also increase the patient through put as the number of control scans are reduced and hence improve the work flow in the CT guided biopsy suite.

Three cases developed pneumothorax in both the groups-all these lesions were deeper (>4 cm from the lung) in location and 3 of the lesions were <1.5 cm and hence the occurrence of pneumothorax is most likely related to these factors rather than non-usage of laser guidance (14).

We also did not find a statistically significant difference in the diagnostic yield between the two procedures. Totally 10 biopsies- 4 done with laser guidance and 6 done without laser guidance did not yield a specific pathology/were deemed non representative.7 out of the 10 biopsies deemed non-representative were bone lesions in line with generally accepted lesser yield for bone biopsies (15,16). The other biopsies-Two abdominal lymphnodal masses and one mediastinal lymphodal mass – reported as necrotic had a diagnosis on repeat biopsies.

Subjectively the laser guidance was most useful when steeper angulations were required as often is the case with CT guided vertebral bone biopsies.

The study is a historical cohort study and hence few minor complications may be under-reported. Also there were no cases with cranio-caudal angulation and hence we could not assess the effect of angulation along the Z-axis between the two groups. However there are very few studies comparing the outcome of CT guided intervention with and without laser guidance and the results of this study could be used to validate a larger randomised trial.

To conclude the laser guidance device we evaluated is compact, portable and easy to use and can be integrated to any CT unit without the need for mechanical hardware or additional software. As there is no mechanical guidance there are no issues related to the maintenance of the sterility of the procedure. The laser unit gives a wide coverage arc of about 200–210 degrees and we could target the lesion in all the 28 patients undergoing the procedure with laser guidance. The usage of the device also shows very promising results with respect to reduction in number of control scans and the total radiation dose.

Conflict of interest

The authors declare that there are no conflicts of interest.

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